(19) Japan Patent Office (JP) (11) Publication number:

(12) Laid-open disclosure public patent bulletin (A) 4-74728

(51) Int.Cl.[5] Identification number JPO file number (43) Date of publication: March 10, 1992
C 03 B 19/01 6971-4G
G 02 B 6/12 M 7036-2K

Request for examination: Not requested, Number of claims: 2 (Total 5 pages)

(54) Title Of The Invention Method and Apparatus for Manufacturing Quartz-Based Optical Waveguide

(21) Application number: 2-182800
(22) Date of filing: July 12, 1990

(72) Inventor: ITO, Masumi c/o Yokohama Works, Sumitomo Electric Industries, Ltd., 1, Taya-cho, Sakae-ku, Yokohama, JAPAN

(72) Inventor: AIKAWA, Haruhiko c/o Yokohama Works, Sumitomo Electric Industries, Ltd., 1, Taya-cho, Sakae-ku, Yokohama, JAPAN

(72) Inventor: KANAMORI, Hiroo c/o Yokohama Works, Sumitomo Electric Industries, Ltd., 1, Taya-cho, Sakae-ku, Yokohama, JAPAN

(71) Applicant: Sumitomo Electric Industries, Ltd. 5-33, Kitahama 4-chome, Chuo-ku, Osaka, Japan

(74) Agent: Patent attorney TANI, Yoshikazu

SPECIFICATION

1. TITLE OF THE INVENTION
Method and Apparatus for Manufacturing Quartz-Based Optical Waveguide

2. WHAT IS CLAIMED IS:

(1) A method of manufacturing quartz-based optical waveguide, comprising the steps of building up, directly on a substrate, glass particulates synthesized by feeding glass raw materials to an oxyhydrogen flame burner, and converting the built-up film into a transparent glass at a high temperature to synthesize a quartz glass film on said substrate, wherein

said substrate on which to build up said glass particulates is disposed on the upper side of said oxyhydrogen flame burner, with the building-up surface of said substrate directed downwards, and

said oxyhydrogen flame burner is so disposed that the flow direction of the jet from said burner is at an angle in the range of from 0° to 85° against the vertical direction.

(2) An apparatus for manufacturing a quartz-based optical waveguide, for use in a method of manufacturing a quartz-based optical waveguide in which a built-up film of glass particulates on a substrate is converted into a transparent glass at a high temperature to synthesize a quartz glass film on said substrate, said apparatus comprising an oxyhydrogen flame burner for jetting glass particulates, synthesized by feeding glass raw materials, onto a building-up surface of said substrate, and a seed rod for supporting said substrate, said glass particulates being built up directly on said substrate, wherein

said substrate on which to build up said glass particulates is disposed on the upper side of said oxyhydrogen flame burner, with said building-up surface of said substrate directed downwards, and

said oxyhydrogen flame burner is so disposed that the flow direction of the jet from said burner is at an angle in the range of from 0° to 85° against the vertical direction.

3. DETAILED DESCRIPTION OF THE INVENTION

[Technical Field of Utilization]

The present invention relates to a method and an apparatus for manufacturing a quartz-based optical waveguide, which is one of flat surface waveguide type optical component parts.

[Prior Art]

As is known, a quartz-based optical waveguide capable of being formed on a quartz glass substrate or a silicon substrate is expected as a means of realizing a practical optical waveguide component part in view of its good matching properties for matching to quartz-based optical fibers.

Fig. 5 shows process step diagrams for illustrating a conventional method of manufacturing a quartz-based optical waveguide. The method of manufacturing a quartz-based optical waveguide will be described in the order of process steps, referring to the drawing.

(a) A glass forming raw material gas containing $SiCl_4$ as a main component is subjected to a flame hydrolysis reaction, to sequentially build up a buffer glass particulate layer 2a and a core glass particulate layer 3a on a substrate 1.

(b) Next, the glass particulate layers 2a and 3a are heated together with the substrate 1 in an electric furnace, whereby the layers are made transparent and a quartz-based optical waveguide film composed of a buffer layer 2b and a core layer 3b is formed.

(c) Subsequently, unrequired portions of the core layer 3b are removed by a reactive ion etching method, to produce ridge-form core lines 3c.

(d) Finally, a clad layer glass layer 4 having a refractive index comparable to that of the buffer layer is built up so as to cover the core fines 3c, by again utilizing the flame hydrolysis reaction or by utilizing a sputtering method using an SiO_2 plate as a target.

Fig. 6 illustrates further in detail the method of building-up the glass particulate layer which plays an important role in the manufacturing process shown in Fig. 5. In the figure, symbol 1 denotes a substrate, 10 denotes a glass particulate synthesis torch, 10a denotes an oxyhydrogen flame, and 11 denotes an exhaust pipe. A glass forming raw material gas containing $SiCl_4$ and the like fed to the glass particulate synthesis torch 10 undergoes a flame hydrolysis reaction in the oxyhydrogen flame 10a composed of O_2 gas and H2 gas, whereby glass particulates are synthesized. The glass particulates thus synthesized are blown together with the oxyhydrogen flame onto a surface of the substrate 1, whereby a glass particulate layer is built up on the substrate 1. In this case, the surplus glass particulates not deposited on the substrate 1 are discharged through the exhaust pipe 11 together with the exhaust gas. The torch 10 and the substrate 1 are moved relative to each other by use of a torch moving device or substrate moving device (not shown), whereby a glass particulate layer uniform in the film surface is built up. In addition, where the concentration of a refractive index control dopant ($GeCl_4$ or $TiCl_4$) in the glass forming raw material gas is varied during the building-up period, it is possible to form distinctly a buffer layer and a core layer.

A quartz-based optical waveguide obtained by the conventional manufacturing method illustrated referring to Figs. 5 and 6 has a low propagation loss of 0.1 dB/cm or below, is high in productivity and weatherability, and is excellent in practicability.

[Problems to be Solved by the Invention]

In the conventional apparatus for manufacturing a quartz-based optical waveguide, the oxyhydrogen flame burner 10 has been directed vertically downwards in building-up the glass particulates on the substrate 1. In this case, since the building-up surface 1a of the substrate 1 is directed upwards, even though the exhaust pipe 11 is provided, impurities present in the reaction vessel and the glass particulates being suspended in the reaction vessel without being built up may drop onto and be deposited on the surface of the substrate 1. This would lead to defects in the glass film, resulting in deterioration of propagation loss.

[Means for Solving the Problems]

According to the present invention, in order to solve the above problems, a substrate is disposed on the upper side of an oxyhydrogen flame burner, with the building-up surface of the substrate directed downwards. This arrangement makes it possible to preclude the possibility that unrequired materials present in the reaction vessel might drop onto and be deposited on the surface of the substrate. In this case, it is necessary that the angle of the flow of the jet from the oxyhydrogen flam burner against the vertical line is in the range of from 0° to 85°, in other words, the angle between the flow from the oxyhydrogen flame burner and the substrate is in the

range of from 90° to 5°.

As for the glass particulates to be deposited and built up on the substrate surface, the particulates are chemically bonded to each other by being sufficiently heated by the burner flame and, therefore, will not be suspended to the upper side. Therefore, even where the building-up surface of the substrate is directed downwards, there is utterly no possibility that the glass particulates deposited on the building-up surface might drop. Incidentally, the substrate may be fixed by a vacuum suction method or may be fixed by use of metallic clamps.

Fig. 1 shows the basic configuration according to the present invention. In the figure, symbol 21 denotes a seed rod, 22 denotes a reaction vessel, 23 denotes a turntable, and 28 denotes an exhaust pipe. A substrate 24 is fixed to the lower side of the turntable 23, glass particulates are synthesized by use of an oxyhydrogen flame 27 jetted skewly upwards from an oxyhydrogen flame burner 26 disposed on the lower side of the substrate 24, and a glass particulate film 25 is deposited and built up on the lower surface 24a of the substrate 24.

[Functions]

In the step of building-up the glass particulates, the building-up efficiency of the glass particulates is 70 to 90%, and, though the particulates not deposited are sucked through the exhaust pipe 28, it is difficult to remove such particulates completely. Therefore, surplus soot is suspended in the reaction vessel, and deposited on the inside walls of the reaction vessel. The soot suspended in the reaction vessel and the soot deposited on the inside walls will highly probably drop downwards inside the reaction vessel, since the particulates are chemically bonded to each other by being sufficiently heated by the burner flame as above-mentioned. Therefore, where the substrate is disposed with its building-up surface directed upwards as in the prior art, it is well considered that the surplus soot will drop onto the building-up surface, notwithstanding the suction through the exhaust pipe.

The present inventors have found out that this problem can be obviated by disposing the substrate 24 on the upper side of the oxyhydrogen flame burner 26 and directing the building-up surface 24a of the substrate 24 downwards. The substrate 24 can be fixed without problem, either by a vacuum suction method using a hollow seed rod 21 as shown in Fig. 2 or by use of metallic or ceramic made clamps 29 as shown in Fig. 3. In this case, as described above, it is necessary that, as shown in Fig. 4, the angle of the flow of the jet from the oxyhydrogen flame burner 26 against the vertical line is in the range of from 0° to 85°, in other words, the angle between the flow from the oxyhydrogen flame burner and the substrate 24 is in the range of from 90° to 5°.

[Example]

In Fig. 1, $SiCl_4$ was fed to the burner 26 at a rate of 300 cc/min, to be subjected to hydrolysis in the oxyhydrogen flame, whereby particulates were produced and were deposited and built up on the substrate 24. The substrate 24 was formed of silicon and had a diameter of 12.7 cm. Twenty substrates 24 were arranged along the outer circumference of the turntable 23 having a diameter of 1 mm. The substrates were fixed by a vacuum suction method. With the turntable 23 rotated at a speed of 1 rpm, the deposition of soot was carried out for 3 hr.

As a result, there was no surplus soot deposited on the building-up surface 24a of the substrate 24, and a thin glass film free of defects was obtained on the substrate 24.

[Effects of the Invention]

As has been described above, according to the present invention, the substrate on which to build up glass particulates is disposed on the upper side of the oxyhydrogen flame burner, with the building-up surface of the substrate directed downwards, whereby the possibility that surplus soot might drop onto and be deposited on the substrate during building-up of the glass particulates on the substrate can be precluded, and a glass film with less glass defects can be obtained on the substrate. Thus the method and the apparatus according to the present invention are effective for application to the manufacture of an optical waveguide with low loss.

4. BRIEF DESCTIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing the configuration of a manufacturing apparatus suitable for a method of manufacturing a quartz-based optical waveguide according to the present invention;

Figs. 2 and 3 are schematic diagrams showing an exemplary structure for fixing a substrate with its building-up surface directed downwards in the present invention;

Fig. 4 is a conceptual diagram for illustrating the angle of an oxyhydrogen flame burner against the

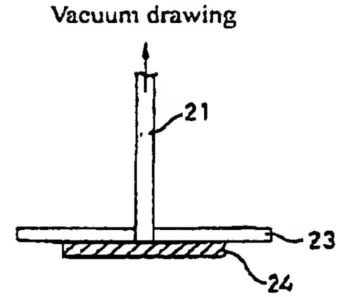
substrate in the present invention;

Fig. 5 shows process step diagrams illustrating a conventional method of manufacturing a quartz-based optical waveguide; and

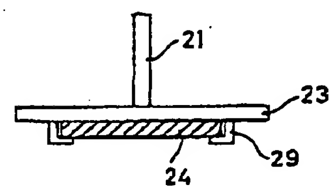
Fig. 6 is a schematic diagram showing the configuration of a conventional apparatus for manufacturing a quartz-based optical waveguide.

21 ····· seed rod
22 ····· reaction vessel
23 ····· turntable
24 ····· substrate
24a···· lower surface of substrate
25 ····· glass particulate film
26 ····· oxyhydrogen flame burner
27 ····· oxyhydrogen flame
28 ····· exhaust pipe
29 ····· metallic or ceramic made clamp

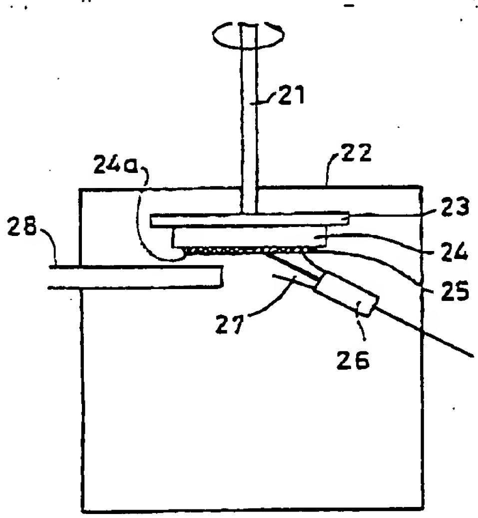
Applicant: Sumitomo Electric Industries, Ltd.
Agent, Patent attorney: TANI, Yoshikazu



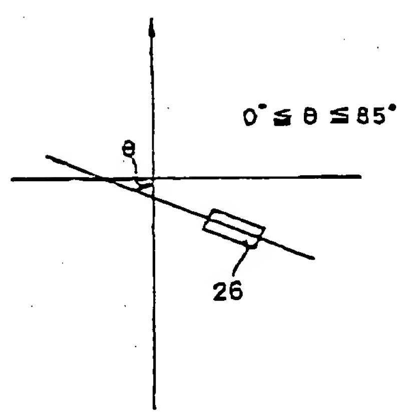
[Fig. 2]



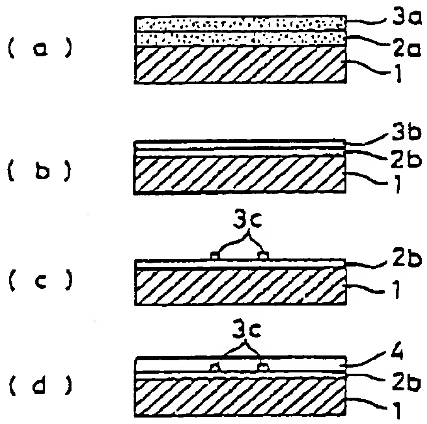
[Fig. 3]



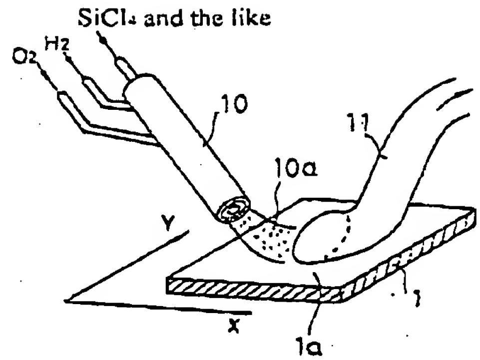
[Fig. 1]



[Fig. 4]


(a)
3a
2a
1
(b)
3b
2b
1
3c
(c)
2b
1
3c
(d)
4
2b
1

[Fig. 5]


SiCl₄ and the like
O2
H2
10
11
10a
Y
X
1a
1

[Fig. 6]